with his theories and the present volume is a welcome contribution because Dr. Pütter gives a more detailed presentation of his views and replies to the more important objections offered by his critics.

The first chapters are preparatory to the discussion of the chief topic, *i. e.*, how aquatic animals obtain an adequate supply of food. They deal with such questions as the intensity of metabolism in the various groups of aquatic animals, the food requirements of these animals, the different types of food of various groups, including both vertebrate and invertebrate forms, and the source of organic substances dissolved in the water. The view is presented that the estimation of the food requirement of an animal should be based upon the area of active absorbing and secreting surfaces, more especially the effective respiratory surface, rather than upon the mass, because the oxygen consumed is a good measure of metabolism, and the rate of consumption of this gas shows the intensity of this process. Calculated on this basis, the author finds that the food requirement of many aquatic animals has been greatly underestimated hitherto and that the total demand in a body of water is frequently greater than the supply of organized food which is produced by it. One instance is cited in which the demand for food by the zooplanktonts of a body of water exceeded the supply of organized food for nine months out of a period of thirteen, and in another instance demand exceeded supply for each of thirteen months. Naturally, this excess of demand over supply raises the question as to how this deficit is made good and the author's answer to this query is his important contribution to the subject under discussion.

Dr. Pütter maintains that aquatic animals have recourse to the organic substances which are always found in solution in natural waters, and in this way the deficiency is supplied. He asserts, in fact, that these dissolved organic substances which are generally present in amounts varying from ten milligrams to twenty milligrams per liter of water are not only drawn upon in emergencies, but that they are the chief source of the food of some forms.

With respect to the ability of aquatic animals to make use of dissolved food an experiment by Knorrich is cited in which *Daphnes* survived for a period of fourteen days on a diet consisting solely of dissolved food. The author himself found that goldfish lived for a period of forty-one days in tap water which contained no organized food and the oxygen consumed substantially accounted for the loss in weight; but when organic substances were dissolved in the tap water, the goldfish survived for seventy-eight days, nearly twice as long, and the oxygen consumed greatly exceeded the amount that would account for the loss in weight. The conclusion drawn from this experiment is that these goldfish were able to make use of the dissolved food, because they lived so much longer when supplied with this kind of food than when given neither dissolved nor solid food, and because of the extra quantity of oxygen consumed.

Solid food is not regarded as a thing which may be dispensed with entirely, but dissolved food may play a more or less important rôle, even to the point of being the chief source of food for some organisms, such as sponges, which frequently appear to receive very little in the way of organized food.

Dr. Pütter's conclusions are not always convincing and there is a paucity of evidence in some instances which serves to show how recently this field has been invaded by investigators; but the views expressed are suggestive and will doubtless stimulate investigations in this field of research and eventually result in giving us a much better knowledge of the nutrition of aquatic animals.

C. JUDAY

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE
SECTION E

THE regular annual meeting of Section E of the American Association for the Advancement of Science was held in Pillsbury Hall, University of Minnesota, December 27, 28 and 29. A program of papers was read both morning and afternoon each day. Due to the unavoidable absence

of Mr. Brock, the vice-presidential address on "Northern Canada" was not read on Wednesday afternoon, but read by title only.

The Weathering and Enrichment of Pyritic Gold Ores: W. H. EMMONS.

Any theory of leaching or enrichment at depth of auriferous deposits involves the solution, transportation and precipitation of gold in cold and moderately dilute solutions. The analysis of underground waters shows that sulphuric acid and sodium chloride are present in practically all waters from pyritic gold mines. Gold is dissolved by nascent chlorine, which in acid solutions is set free by nitric, manganitic, ferric or cupric compounds. Since nitrates are seldom shown in the analyses, they are believed to be of little or no importance in this connection; ferric and cupric compounds release nascent chlorine only in hot or in concentrated solutions. As shown by Brokaw's experiments appreciable gold is dissolved in fourteen days in cold solutions containing but 1,418 parts per million of chlorine, when manganese is present. In a similar solution without manganese no gold is dissolved. As shown by McCoughy a very small amount of ferrous salt will precipitate gold dissolved in chlorine solution. Consequently the auriferous solution could not travel far through deposits where pyrite is oxidizing to ferrous sulphate. But manganitic compounds such as pyrolusite very quickly oxidize ferrous salt to ferric salt. Thus manganitic compounds not only release the nascent chlorine which dissolves gold but they also inhibit the precipitation of gold by ferrous salt, thus permitting the gold to travel farther in solution.

But these laws apply only to acid solutions. At greater depths where acid is used up to form neutral or basic salts by reactions with the wall rock, the system breaks down and gold together with manganese oxide is precipitated. Indicating these reactions certain manganiferous gold deposits are found in depth to consist of pyritic gold ore cut by fractures which are filled with rich veinlets of auriferous powdery manganese oxide (probably manganite, in the main).

It follows from these premises that manganiferous gold deposits are less likely to yield gold placers than non-manganiferous deposits; that outcrops of manganiferous lodes are more likely to be leached of gold near the surface; that non-manganiferous lodes are less likely to contain secondary gold bonanzas. It is believed that these relations are indicated by the pyritic gold deposits of the United States.

The Genesis of Certain Greensands of Minnesota: N. H. WINCHELL.

The greensands discussed were: (*a*) that which occurs in the valley of the Blue Earth River, discovered in 1700 by Le Sueur and mined by him in the belief that it was an ore of copper, and (*b*) that which occurs on the Mesabi iron range, called glauconite and greenalite, and regarded by some as the source of the iron ore of that range and of other Lake Superior iron ranges.

The former was shown to be so closely associated with the residual products, such as kaolin, that it must be considered to result from the decay of the Upper Cambrian strata with which it is found. The chemical and physical characters were given, samples were shown, and finally, photographs of the bluffs showing the deep disintegration of the strata along the Omaha Railroad. Kidney iron ore (with the shape of limestone pebbles, which have been a standing puzzle to Minnesota geologists) was another product of this same disintegration, which was in some way dependent on the presence of the Cretaceous ocean, which covered the locality.

The greensand of the iron ore ranges of Minnesota has been reinvestigated by means of thin sections of a drill core furnished by Mr. E. J. Longyear, of Hibbing. This core was representative of a drill that went through the Mesabi rocks, to a depth of 2,049 feet. One hundred and six thin sections were examined. Throughout the core, beginning at the top of the black slate and continuing to near the horizon of the iron ore, the rock is characterized by the predominance of an isotropic substance in grains of all shapes, evidently sedimentary, though seldom in distinctly detrital or rounded forms. The supply of material was so rapid that there was not enough friction to round the grains thoroughly. Mingled with these grains are angular grains of quartz and other minerals. The isotropic grains resembling glass, are seen to contain bubbles and globular incipient minerals. They are sometimes slightly greenish, and sometimes brownish, but have a high index of refraction. They are sometimes partly and even wholly opaque, and black, and when opaque they are variable in form. These obvious primary microscopic characters indicate that this isotrope is of volcanic glass, and the secondary microscopic characters agree with

that conclusion. Quartz, actinolite, calcite and iron ores appear as alteration proceeds, and their relations have been noted. The green mineral first appears at a depth of 1,508 feet, where it is only partially developed and hardly to be distinguished from the isotropic glass. It occurs in various forms and first attracted attention as it took the rounded form of the original glass pellets, wholly free from other secondary minerals. The detailed relations were examined. Geodic structure often appeared.

Inasmuch as these several secondary minerals often lie in a matrix of greenalite, it has been assumed that they have been developed from the greenalite by chemical separation. But an identical fact is seen in the relations of secondary quartz. Magnetite, actinolite, and even greenalite and calcite are similarly surrounded by quartz. From analogy, one might assume that these minerals were generated from quartz. On such an assumption any one of the minerals could be proven to be derived from any of the others.

These considerations put a veto on the idea that the iron ore is derived from the greenalite. It is a secondary product coordinate and connate with the quartz and with the iron ore.

An Example of Limonite Deposition: OLIVER BOWLES.

A small occurrence of limonite at Sturgeon Lake, in the Thunder Bay District of Ontario, is described. Surface waters have dissolved pyrite from a pyritic quartz vein which is exposed on a hillside, and the dissolved iron is deposited in the form of a limonitic cement amongst the pebbles of the talus slope.

The points to which attention is specially directed are: (1) evidence of total solution of pyrite by rain water assisted only by dissolved gases; (2) the large extent of the deposit when compared to its limited source of supply; (3) the presence of ferrous sulphate as an intermediate stage in the process of alteration. The unstable nature of ferrous sulphate when considered in connection with the close proximity of the pyrite and limonite would lead one to expect that limonite deposits of pyritic origin, in regions free from carbonate reaction, would be found close to the source of supply.

The Geology of the Cuyuna Iron Ore District of Minnesota: CARL ZAPFFE.

Cuyuna District is located in central Minnesota and is the youngest iron-ore district in the Lake Superior region. No rock outcrops point directly to its location, but its existence was conjectured from the geological structure of the Lake Superior region as a whole and that of the different iron-ore districts embraced therein. Numerous well-defined belts of magnetic attraction enable systematic and productive explorations with diamond drills, and the geology of the district has been determined solely from carefully collected data of about 1,900 drill holes. The geology of the district is interpreted to be that of a closely folded heterogeneous slate formation of Upper Huronian age and containing in its lower horizon interbedded sedimentary lenses of iron-bearing formation which, upon being exposed by folding and erosion, have frequently altered through descending meteoric waters into low-grade iron ores at the erosion surface. Basic post-Huronian igneous rocks seem to be exclusive within the ore-bearing area and predominate over the acid phase in the outlying areas.

The Relation of Texture to the Composition of Coal: FRANK F. GROUT.

Proximate and ultimate analyses are reported of seven samples from a coal mine at Marshall, Colorado. The samples represent different textures from a single seam, and in the report they are distinguished by the following names: (1) average, (2) glance coal, (3) splint coal, (4) mineral charcoal or "mother coal," (5) cannel-like coal, (6) resin? (7) slate, (8) bone coal.

It is seen that the average of the seam is sub-bituminous, but that by any of the standard methods of chemical classification the small samples vary from lignite to semi-bituminous coal. The analyses have considerable importance in discussions of the origin of coal, and further, may explain some of the variation in samples from a single seam. It is well known that such constituents as the resin and charcoal occur quite erratically in various parts of the mines.

The Geology of Harding County, South Dakota: ELLWOOD C. PERISHO.

This area is located in the northwest corner of South Dakota. Topographically the chief feature is a plain about 3,000 feet in elevation with several buttes and a few valleys. The buttes are about 500 feet high; good examples are Cave Hills, Short Pine Hills and Slim Buttes; while the chief valleys are the Little Missouri, Grand and Moreau. The geological formations are the Fort Pierre, Cretaceous to Loup Fork and Mio-

cene. Unconformities occur between the Fort Union and White River and between the White River and Loup Fork, while folds and faults occur locally in the Pre-Loup Fork beds of Short Pine Hills, etc. There are few fossil plants and animals. Coal (lignite) of lower Fort Union age occurs in seams a few inches to ten feet thick.

The buttes are attributed to either (1) a chert layer of the White River, (2) a massive Fort Union sandstone, (3) local thick coarse beds of Loup Fork, (4) combinations of the above.

Soil has been extensively removed and caves worn in the cliffs by the work of wind. At Slim Buttes and Short Pine Hills extensive slumping has developed. Some terraces in the Little Missouri Valley may be due to the post-Pliocene climatic changes.

Northern Canada (address of the retiring vice-president): R. W. BROCK. Read by title only.

Geology of the Olympic Peninsula, Washington: A. B. REAGAN.

In the Olympic Peninsula the following formations are exposed (1) Old Cretaceous (Point of Arches group); (2) Cretaceous and possibly older (Point Granville, Pacific coast in general, and central high area); (3) Eocene (Volcanics near Port Crescent); (4) Oligocene-Miocene (Fresh Water Bay and east of Gettysburg flank of the Point of Arches Group); (5) Pliocene (Hoko formation on the Strait, Raft and Quinault formations toward Point Granville, and Quillayute formation in the interior to the northeast of La Push on the Pacific), and (6) Pleistocene (covering all the region but the upper stretches of the eastern tributaries of the Quillayute River). In all between 20,000 and 30,000 feet of rocks are exposed.

The rocks of (4) contain many fossils very similar to the Tertiary near Astoria, Ore. They are also coal-bearing, the Clallam Bay Mine producing 200 tons or more per month. Coal is also exposed in the Quillayute-Bogachiel country and on the Pacific coast near Cape Johnson, and also near the Point of Arches. Oil springs occur at Hoh Head, on the Pacific side of the peninsula.

The Geologic Map of North Dakota: A. G. LEONARD.

The geologic formations represented on the map are the Benton, Niobrara, Pierre, Fox Hills, Lance (*Ceratops* beds)?, Fort Union and White River. The Benton and Niobrara occur in the northeastern corner of the state, in the Pembina Mountains. The black to bluish gray Pierre shale covers most of the eastern half outside the Red River Valley, and also outcrops in the Missouri River Valley for twenty miles above the South Dakota line, and in a small area in northwestern Bowman County. The Fox Hills sandstone occurs in the latter locality and on the Missouri River as far north as old Fort Rice. The Lance beds cover a large area in south-central North Dakota, and a smaller area in the southwestern corner of the state. The Fort Union occupies much of the western half of the state, and in it most of the lignite beds are formed. The White River beds form several small areas in Billings County.

The character of the various formations is discussed.

A New Use of Lignite: E. J. BABCOCK. Read by title only.

Coals and Clays of North Dakota: E. J. BABCOCK. Read by title only.

Geologic Features of Nebraska: E. H. BARBOUR. Read by title only.

Lake Superior as a Former Igneous Center: ROBERT BELL. Read by title only.

The General Structure of the Florence Iron District: W. O. HOTCHKISS.

The Florence Iron District is the extension into Wisconsin of the Menominee district of Michigan. The Quinnesec schists south of both districts have been considered to be the basement on which the iron-bearing series was deposited and therefore the possibility of developing new iron districts to the south deemed very slight. Work of the past field season has shown that these schists overlie the iron-bearing series. The general structure of the Florence district is monoclinal from a broad point of view, with local folding in the slate series in which the iron formations are interbedded.

The iron-bearing series has a southward dip and disappears under the schists. This makes it more probable that the series may reappear beneath the glacial drift to the southward and makes careful work in the drift covered pre-cambrian area to the south of great economic importance.

The Geothermal Gradient: ALEXANDER N. WINCHELL.

It is generally agreed that the earth is a cooling body. Calculations of the thermal gradient within the earth, based on the laws of a cooling body, have shown that the gradient thus derived does not deviate from a straight line to any important amount within a depth of fifteen or twenty miles.

Therefore, it has been assumed that temperatures approximating fusion conditions would be found at about twenty miles depth, but such computations ignore the effects of radioactivity on the geothermal gradient. Therefore the subject needs reexamination in light of new data.

A study of the subject leads to the conclusion that radioactivity supplies not less than one sixth nor more than one half of the annual heat loss of the earth. It appears, further, that this source of supply of heat must be largely concentrated near the surface of the earth. Therefore, the actual temperature gradient within the earth can not be approximately a straight line, as derived from the laws of cooling, but must curve constantly and at a rate which depends upon the amount of heat produced within the earth by radioactivity at various depths. After making due allowance for the effects of radioactivity and cooling upon the geothermal gradient it appears that temperatures approximating fusion conditions are to be expected at a depth of about thirty miles instead of twenty miles. Further, it appears that if radioactivity supplies much more than about one quarter of the annual heat-loss of the earth the nebular hypothesis as ordinarily understood must be incorrect.

Finally (as pointed out by Becker), by making proper allowance for the effect of radioactivity, Kelvin's estimate of the age of the earth is brought into harmony with the best estimates derived from other sources, instead of standing as heretofore, as a perpetual challenge to the accuracy of other estimates.

Terrestrial Deposits of Owen's Valley, California: ARTHUR C. TROWBRIDGE.

Alluvial deposits occur as fans and piedmont alluvial plains on either side of Owen's Valley, Cal. On the Sierra side the deposits are fluvio-glacial. At the foot of the Inyo Mountains there are deposits of two ages. The materials range in size up to bowlders thirty feet in diameter. They are sorted roughly into lenses and pockets. The fans are now being dissected. The cause of deposition is decrease in velocity and volume of streams from the mountains.

Huge bowlders are transported in the following manner: The stream moves fine material from in front of the bowlder and piles other material behind it. As the bowlder is undermined it falls over into the depression. This process is repeated time and again, resulting in periodic motion for the bowlder.

Dissection has followed great fluvio-glacial deposits on the surface of the fans, these deposits bearing relations to present conditions similar to those between a valley train and normal stream erosion.

Criteria are presented for the distinction of such deposits from still water deposits.

Note on a Method in Teaching Optical Mineralogy: F. W. MCNAIR. (To be published in *Am. Jour. Science.*)

In the effort to condense optical mineralogy, the form of the wave shell and deductions therefrom have been rested as directly as possible upon the so-called reciprocal ellipsoid of McCullough. If one may judge by the text-books, the ellipsoid, whether that of Fresnel or this of McCullough, is used in the non-mathematical presentations of the subject to obtain the wave shell or its three principal sections, and is then immediately abandoned. The device, which occurred to me some years since and which I have found useful in obtaining results with my students, is to carry the use of the ellipsoid into a considerable number of the applications of the theory to the properties of crystals. Perhaps the most conspicuous example of its usefulness lies in its application to the distinction between positive and negative crystals in convergent polarized light. Details can not be abstracted.

Its justification rests in the readiness with which a student who once comprehends the meaning of the ellipsoid becomes independent in his application of the test of the quartz wedge, applying the wedge in either position and reasoning out his results with an assurance of correctness.

Indications of a Huronian Continental Angle: H. B. AYERS.

A belt of Huronian beds will probably be found parallel to the Rocky Mountains through the Dakotas, Alberta and northwestward, forming a continental angle with the Minnesota belt probably in the vicinity of the Black Hills. A few outcrops of quartzite and slates and some topographic and drift data supply the foundation for the conjecture.

The Dam Lake Quartzite: H. B. AYERS.

The quartzite of Dam Lake (Aitkin County, Minn.) has been explored by drilling through both contacts with adjoining rock and the results prove it to be the equivalent of the Pokegama quartzite, and here overlying the Keewatin formation.

Evidences of Pleistocene Crustal Movements in the Mississippi Valley: J. E. TODD. Read by abstract.

Recent studies show that the glacial deposits of Kansas indicate: (1) A marked easterly trend. This appears from the direction of striæ, character of bowlders, etc. The ice came from the Minnesota valley, not from the Dakota. (2) The edge of the ice reached, in Pottawattamie County, Kansas, an altitude of 1,500 feet A. T. Taking a common point in northern Kossuth County, Iowa, and assuming a uniform average slope, it is shown that with the surface at present altitudes, if the ice reached Blaine, Kan., in the Kansan epoch, it should have reached scores of miles farther east in northeastern Iowa, and seventy or eighty miles further southeast in central Illinois, than any trace has yet been found. From this it is argued that the surface at that time was higher in the latter localities and lower in Kansas.

Corroborating facts are found: (1) in the trough of the Mississippi being 100 to 200 feet deeper than is now necessary to fit the present levels of drainage, while (2) in Kansas the levels of pre-glacial drainage and Kansan drainage were 80 to 100 feet higher than at present. (3) The stronger easterly trend in eastern Iowa of the ice of the Iowan epoch, as compared with that of the Kansan agrees with the conclusion that the change of levels took place between the two epochs, presumably in response to the presence and weight of the ice.

Fault Scarps of the Basin Ranges: CHAS. R. KEYES. Read by abstract.

In the instance of the Basin-Range type of mountain structure normal faulting on a prodigious scale was long regarded as the principal factor. Its mountain-block was considered as upraised. The face of the hard mountain rock rising abruptly out of the less resistant valley deposits was believed to represent a true fault-scarp. This hypothesis is not exclusive; nor is it very satisfactory.

A main objection to the theory is the fact that the evidences of recent displacement are seldom ever disclosed at or even near the so-called fault-scarps. Whenever the line of major faulting is discovered it is miles away from the mountain foot—out on the intermont plain.

On the theory of general denudation of arid regions chiefly through means of eolic rather than aqueous agencies the belt of maximum deflation is at the foot of the desert ranges—where the mountain meets the plain. Within the limits of this narrow belt the topographic result is a tendency towards a steep, plain-like slope. This piedmont belt chances also to be the horizon where torrential water action is most pronounced, cutting deep canyons in the mountain and spreading out detrital fans on the plains. In the struggle between water and wind for corrosive supremacy the results in the mountain area are a succession of sharp ridges trending at right angles to the range-axis, sharply truncated at their lower end by deflative action. The faceted mountain foot thus produced resembles closely the ideal effects of a fault-bounded upraised mountain-block the dissection of which is well advanced.

Modified Drift in Minnesota: WARREN UPHAM.

In respect to their origin and mode of deposition the drift formations of the Ice Age comprise two classes: (1) glacial drift, in the various phases of the till and morainic deposits, produced directly by the agency of ice-sheets, without modification by water; (2) modified drift, derived from erosion and transportation by land ice, but also to some extent transported and deposited by water, being thus waterworn, assorted and more or less stratified.

This second class of the drift deposits, described in its development in Minnesota, includes the valley drift gravel, sand and clay, and also frequent tracts of sand and gravel plains outside the present courses of drainage, but occupying areas where considerable streams of water, well laden with sediments, were discharged from the melting and retreating ice fields. Relatively small parts of the modified drift are amassed here as kames and eskers, which are respectively knolls and long ridges of gravel and sand formed by the brooks and rivers of the glacial melting, the heaped and ridged form of these deposits being due to accumulation at the mouths and in the ice-walled channels of the streams.

The ratio or proportion of the modified drift and glacial drift in Minnesota is estimated as one to three or four. This somewhat large proportion modified and deposited by water, is regarded by the author as an evidence that much of the drift was contained in the lower part of the ice sheet, and that it was finally exposed on the surface of the waning ice fields to the action of streams formed by the melting and by attendant rains.

Fluctuations of the Keewatin and Labradorean Ice Currents in the Vicinity of Minneapolis and St. Paul: WARREN UPHAM.

The currents of glaciation in western and south-

western Minnesota moved to the south and southeast, bringing gray till, with plentiful limestone bowlders, cobbles and finer drift. This area was a part of the Keewatin division of the continental ice-sheet, with outflow southward from Manitoba, Saskatchewan and Keewatin. In northeastern Minnesota the glacial currents belonging to the outer part of the broad Labradorean ice-field, moved to the southwest and south, bringing reddish till, colored by the red sandstones and shales of Lake Superior. The red drift is destitute of limestone bowlders and detritus, because that part of this state and the adjoining region northeastward have no limestone formations. The Keewatin and Labradorean currents were confluent, or they met and opposed each other on a belt that extends from St. Paul and Minneapolis northward and northwestward through Minnesota to the vicinity of Winnipeg.

Gray drift forming the surface and overlying the red drift on a large tract from Lake Minnetonka east and northeast to Rush City, Minn., and to the contiguous border of Wisconsin, shows that after the edge of the Labradorean ice-field had occupied that area its drift was covered by an advance of the edge of the Keewatin ice-field.

Numerous sections in St. Paul, observed in the distance of about three miles from the new capitol to Lake Como, show that stratified drift gravel and sand, mostly from the northwest, with abundant limestone, are covered by a thin surface deposit of till from the northeast, having no limestone. The latest fluctuation of the waning ice-sheet there is thus known to have been a readvance of the Labradorean margin, spreading a thin mantle of its englacial till.

The Glacial Lake of the Fox River Valley and Green Bay and its Outlet: S. WEIDMAN.

An introductory statement was made of the succession of glacial lakes in the basins of the Great Lakes, and the generally accepted theory of their origin by ice dams on the retreat of the latest (Wisconsin) ice sheet. Professor Upham pointed out the probable existence of such a lake in the Fox Valley, suggesting the name Lake Jean Niccollett, but not describing the shore lines or outlet. Recently discovered shore lines in the valley and about Green Bay occur at about 20, 40, 70, 95, 150, 220 and 250 feet above the present level of Green Bay. The higher shore lines are at 800 and 830 feet above sea-level, developed on the outlet to the Mississippi River by way of the Wisconsin, the outlet being below the mouth of the Baraboo River, south of Portage. The lower shorelines marked stages in the lake with outlets probably first through Lake Chicago and later through to the Atlantic. The shore lines appear to be horizontal throughout.

The outlet for altitudes of 800 and 830 feet developed across what seems to have been the divide between the Fox and lower Wisconsin River systems, this divide being between the mouth of Baraboo River and Merrimac. The Wisconsin River above Portage was formerly a part of the Fox River system, and through the development of the lake outlet was captured by the lower Wisconsin, a tributary of the Mississippi. During flood the Wisconsin now overflows to the Fox across the low flats in the vicinity of the canal and old Indian portage at Portage, the overflow following approximately the former course.

Characteristics of the Glacial Drift Sheets in Minnesota: FREDERICK W. SARDESON.

A brief historical review of recognized drift sheets in Minnesota, the Old Drift, the Young Drift and recognizable divisions of these, were given, followed by a description of their general characters. Local variations in the character of the several sheets were considered with discussion of means employed to identify them under various conditions. The progress of new investigations by Leverett and others in Minnesota was also represented.

The Pleistocene of a Portion of the Missouri Valley: B. SHIMEK.

A discussion of the distribution and extent of the Nebraskan drift, the Aftonian interglacial silt, sand and gravel, and the Loveland joint clay, as revealed by recent field studies. Evidence that the drift of the extreme northwestern part of Iowa, and adjacent territory is Kansan, and that the Wisconsin is absent from that section. The wide distribution of at least two loesses is noted.

The Æolian Origin of the Loess: B. SHIMEK.

The evidence furnished by distribution, composition and fossils is briefly reviewed. Elimination of fossils formerly improperly included in the loess series. Additional evidence furnished by observations on the drifting of sands, dust and snow, on plant distribution and distribution of the loess along streams. A brief summary of objections to all other theories of origin of loess.

Chains of Lakes in Martin County, Minn., as Evidence of Extensive Recession and Readvance of the Ice-sheet: WARREN UPHAM. Read by abstract only.

Three series of lakes extend across Martin County, one of the central counties of the most southern tier in Minnesota. Till forms the moderately undulating and almost level country inclosing these lakes, which are usually joined by a stream. In several places, however, a watershed passes across a lake chain, and such higher divides between closely adjoining lakes of the chain likewise consist of till, retaining their contour as molded by the ice-sheet, without effects of water in deposition or in erosion. These very remarkable chains of lakes seem explainable only by regarding them as proofs of a fully developed interglacial system of drainage running there from north to south, which became afterwards ice-enveloped in the Iowan and Wisconsin stages of the glacial period.

Near Rush City in Chisago County, about fifty miles north of St. Paul, and at Barnesville, Clay County, in the southern part of the Red River Valley, fossiliferous beds and associated modified drift were overspread by till of a later glacial readvance. Probably this renewal of glaciation covered nearly all the south half of Minnesota, extending over Martin County with partial filling of its interglacial river courses, and continuing to the most southern limits of the Wisconsin drift sheet west of the Mississippi River, near Des Moines, Iowa, distant from Barnesville about 400 miles to the south-southeast.

The Glacier National Park: M. J. ELROD.

About 125 colored lantern slides, mostly from the author's negatives, showing the condition, surroundings and effects of the several glaciers of the park.

Observations on Changes of Level on the Atlantic Coast Line from Cape Cod to Cape Race (Newfoundland): G. C. CURTIS. Read by abstract only.

A series of observations have been completed on the coast and outlying islands between Cape Cod and Cape Race. The general character is that of old mountains partly submerged and subsequently elevated. Local differential movements appear to be a characteristic throughout the area. Sections of coast plain alternate with florded indents. Since glaciation there has been a very general elevation of between twenty and forty feet, sometimes more and sometimes practically none. In general the Nova Scotia coast appears to have remained longer at the present level than that of Maine. The character of local coast features has been modified by glacial drift.

The Contribution which the Naturalistic Model is bringing to Earth Science: G. C. CURTIS. Read by abstract only.

Up to the last decade, representation of the earth's surface has been generally held an empirical subject. Modern science has permitted its development along natural principles. To-day it may be considered an exact art based on the laws of nature. We are just beginning this work, which has probably the power to bring a more general interest and better appreciation for the land on which we live than has before been possible. The distinction between the diagrammatic relief map and the true model is now being generally used; under the auspices of Alexander Agassiz, a naturalistic model of the topographic type has been made of the coral island Bora Bora, and installed in the Museum of Comparative Zoology (Harvard). The naturalistic model is the most perfect representation that can be made of the earth's surface, giving a truer conception of the forms of geography than can possibly be obtained otherwise. The results based on following natural principles are so far superior to those of the mechanical methods and the work has so different an appearance that it seems like a different subject.

Geographic Influences in the History of Michigan: G. J. MILLER. Read by title only.

Original Geographic Work: ROBT. BELL. Read by title only.

Reciprocal Intercision by Parallel Streams: G. H. CHADWICK. Read by abstract.

Two parallel streams cut through the beaches of former Lake Iroquois, in the town of Lorraine, Jefferson County, N. Y. When close to the lake, these streams meandered somewhat, and one captured a tributary of the other. Since the lowering of the lake level, both streams have cut gorges in the soft shale. In much more recent times, the tributary mentioned has, in one of its meanders, up stream from the first point mentioned, cut through the wall of the larger canyon and given itself up; it can hardly be called a capture by the larger stream.

Artesian Water of South Dakota: ELLWOOD C. PERISHO. Read by title only.

The Material Conditions of a Municipal Water Supply: C. W. HALL.

A study has been made of the water from all the local geological formations and from the various surface sources. Several points are worthy

of special notice: (1) A general tendency toward an increase in hardness with depth, or with age of the rocks from which the water is drawn. (2) A tendency for the hardness of the water to decrease, if drawn extensively and continuously from a certain sandstone for several years. (3) The clear evidence furnished by the chlorine determinations, of pollution of surface waters and shallow wells in the cities. In south Minneapolis—the older, more densely settled part of town—shallow well waters contain 44 parts per million of chlorine, while in other, less settled parts, 4 parts per million is the maximum. A few analyses follow:

	1	2	3	4	5	6	7	8
Total solids	202.1	247 3	303 9	288.5	386.9	220.0	327.6	236.0
Silica	16.6	18 2	11.6	12.3	16.8	5.0	13.1	6.7
Iron oxide, etc	.7	1.3	1.9	1.3	5 7	.6	3.1	2.2
Calcium	40 3	52.2	60 1	63.1	95.1	57.5	75.3	51.5
Magnesium	12.7	16 8	25.1	26.1	24.6	22.0	29.1	20.1
Sodium and potassium	4.8	13.1	7.1	9 4	11.3	6.8	6.5	10.2
Carbonate radicle	trace	4.2	.8	2.6				
Bicarbonate radicle	201.3	207 8	293 2	288 6	414 5	278.0	377 5	252 0
Sulphate radicle	3 5	19 6	11 0	8 4	19 8	4 0	15.5	2 7
Chlorine	2.2	8 6	5 3	5.6	6.9	4.6	2 4	5.3

It is noteworthy that samples number 6 and 8 from St. Paul have lower mineral content than samples number 5 and 7 from Minneapolis, though from the same formations. The amount of water taken from these formations in St. Paul is much greater than in Minneapolis.

1. Lake and river waters.
2. Waters from wells in glacial drift.
3. Saint Peter sandstone waters.
4. New Richmond sandstone waters.
5. Jordan sandstone waters of Minneapolis.
6. Jordan sandstone waters of St. Paul.
7. Dresbach sandstone waters of Minneapolis.
8. Dresbach sandstone waters of St. Paul.

FRANK F. GROUT,
Acting Secretary

SOCIETIES AND ACADEMIES

THE AMERICAN MATHEMATICAL SOCIETY

THE one-hundred and fifty-second meeting of the society was held at Columbia University on Saturday, February 25. Thirty-eight members attended the two sessions. President Henry B. Fine occupied the chair. The council announced the election of the following persons to membership in the society: Dr. Elizabeth R. Bennett, University of Nebraska; Mr. Daniel Buchanan, University of Chicago; Dr. H. B. Curtis, Columbia University; Mr. L. L. Dines, University of Chicago; Professor C. R. MacInnes, Princeton University; Professor Eva S. Magiott, Ohio Northern University; Mr. R. E. Root, University of Chicago; Professor Sarah E. Smith, Mount Holyoke College. Six applications for membership were received.

The following papers were read at this meeting:

E. J. Miles: "Some properties of space curves minimizing a definite integral with discontinuous integrand."

N. J. Lennes: "A necessary and sufficient condition for the uniform convergence of a certain class of infinite series."

N. J. Lennes: "Duality in projective geometry."

G. A. Miller: "The number of the abelian subgroups in the possible groups of order 2^m."

C. N. Moore: "On the uniform convergence of the developments in Bessel functions."

G. D. Birkhoff: "A direct method for the summation of developments in Lamé's functions and of allied developments."

Edward Kasner: "Equitangentials in space."

Edward Kasner: "Conformal and equilong invariants of horn angles."

J. A. Eiesland: "On a contact transformation in physics."

D. C. Gillespie: "Definite integrals containing a parameter."

Joseph Bowden: "The Russian peasant method of multiplication."

N. J. Lennes: "A direct proof of the theorem that the number of terms in the expansion of an infinite determinant is of the same potency as the continuum."

Harris Hancock: "On algebraic equations that are connected with the cyclotomic equations and the realms of rationality which they determine."

W. B. Fite: "Irreducible homogeneous linear groups of order p^m and of degree p or p^2."

The next meeting of the society will be held at the University of Chicago on Friday and Saturday, April 28–29. On this occasion Professor Maxime Bôcher will deliver his presidential address, the subject of which will be "Charles Sturm's Published and Unpublished Work on Differential and Algebraic Equations." Except for the summer meetings, this will be the first convention of the whole society since 1896. A large attendance is expected from both east and west.

The San Francisco Section of the society will meet at Stanford University on Saturday, April 8.

F. N. COLE,
Secretary